Filtration & Clarification

- **Filtration** is defined as the process in which particles are separated from a liquid through a permeable medium. The porous filter medium allows liquid to pass but separates solid particles.
- **Slurry or Feed-** The mixture of solid & liquid to be filtered is known as slurry.
- **Filter medium-** The porous membrane used for filtration.
- **Filter cake-** The accumulation of solid on the filter is known as filter cake.
- **Filtrate-** The clear liquid passing through the filter is known as filtrate.

- **Clarification** is the term used when the solid present in the liquid does not exceed 1 % & the filtrate is the required product.

- **Mechanism of filtration**:
- The flow of solid particle is restricted by the filter medium & the liquid is allowed to pass.

- During filtration solid particles on filter media gets accumulated & acts as a secondary filter medium.

Pharmaceutical Application of Filtration

- Filtration is done to get clear solutions during preparation of syrups, oral liquids, drops, etc.
- It removes solid particles present in the liquids & avoids contamination.
- It is also used to sterilize liquid products.
- It is used to prepare homogenous mixture of liquids.

Theory of filtration

- The rate of filtration is directly proportional to permeability constant for filter medium & filter cake (K), area of filter bed (A) & the pressure difference across the filter medium & filter cake (ΔP) & inversely proportional to thickness of the filter cake (l) & viscosity of the fluid (η). It is called as Darcy's law.

$$\frac{dv}{dt} = \frac{KA\Delta P}{\eta l}$$

Factors affecting the rate of filtration

- The factors affecting the rate of filtration of any liquid is expressed by Darcy's Law which is given as:

$$\frac{dv}{dt} = \frac{KA\Delta P}{\eta l}$$

1) **Area of the Filter Surface**

Rate of Filtration is directly proportional to the Filter surface area $\frac{dv}{dt} \propto A$

2) **Particle size of the solids**

Rate of Filtration is directly proportional to the particle size of the solids to be removed.

$$\frac{dv}{dt} \propto \text{Particle size}$$

3) **Pore size of the Filter Media**

Rate of Filtration is directly proportional to the pore size of the filter media.

$$\frac{dv}{dt} \propto \text{Pore size}$$

4) **The resistance of the filter cake & filter media**

Rate of Filtration is inversely proportional to the resistance of filter cake & filter media.

$$\frac{dv}{dt} \propto \frac{1}{\text{resistance of filter cake \& filter media}}$$

5) **Viscosity of the liquid to be filtered**

Rate of Filtration is inversely proportional to the viscosity of the liquid to be filtered.

$$\frac{dv}{dt} \propto \frac{1}{\eta}$$

6) **Temperature**

When temperature increases viscosity decreases and hence rate of filtration increases.

7) **Pressure Difference across the filter**

Rate of Filtration is directly proportional to the pressure difference across the filter.

$$\frac{dv}{dt} \propto \Delta P$$

Filter Media

- The surface or medium upon which solids are retained in the process of filtration is known as filter media.
- An ideal filter media should have following properties:

1. It should be chemically inert (non-reactive).
2. It should have high retention power for the solids but should allow maximum passage of liquids.
3. It should have sufficient mechanical strength to withstand filtration pressure.
4. It should absorb negligible amount of dissolved material.
5. It should be resistant to the corrosive action of the liquid.

- While selecting the filter media, the following factors must be taken into consideration:

1. The size of the particles to be filtered.
2. The amount of the liquid to be filtered.
3. Nature of the product to be filtered. e.g: solution, suspension or viscous preparation
4. Purpose of the filtration. e.g: clarification, sterilization

- Some Filter media used in filtration are:

1. Filter Paper
2. Sintered Glass
3. Membrane Filters
4. Cartridge Filters
5. Cotton wool
6. Glass wool
7. Asbestos
8. Woven materials

Filter Aid

- The substances which are added to the liquid to be filtered that reduces the resistance of filter cake & increases filtration are known as filter aid. These substances form porous, non-compressible cake which can retain solid particles but allows liquid to flow through it. Usually 0.1-0.5% filter aid can be added to the liquid to be filtered.

- An ideal filter aid should have following characters:

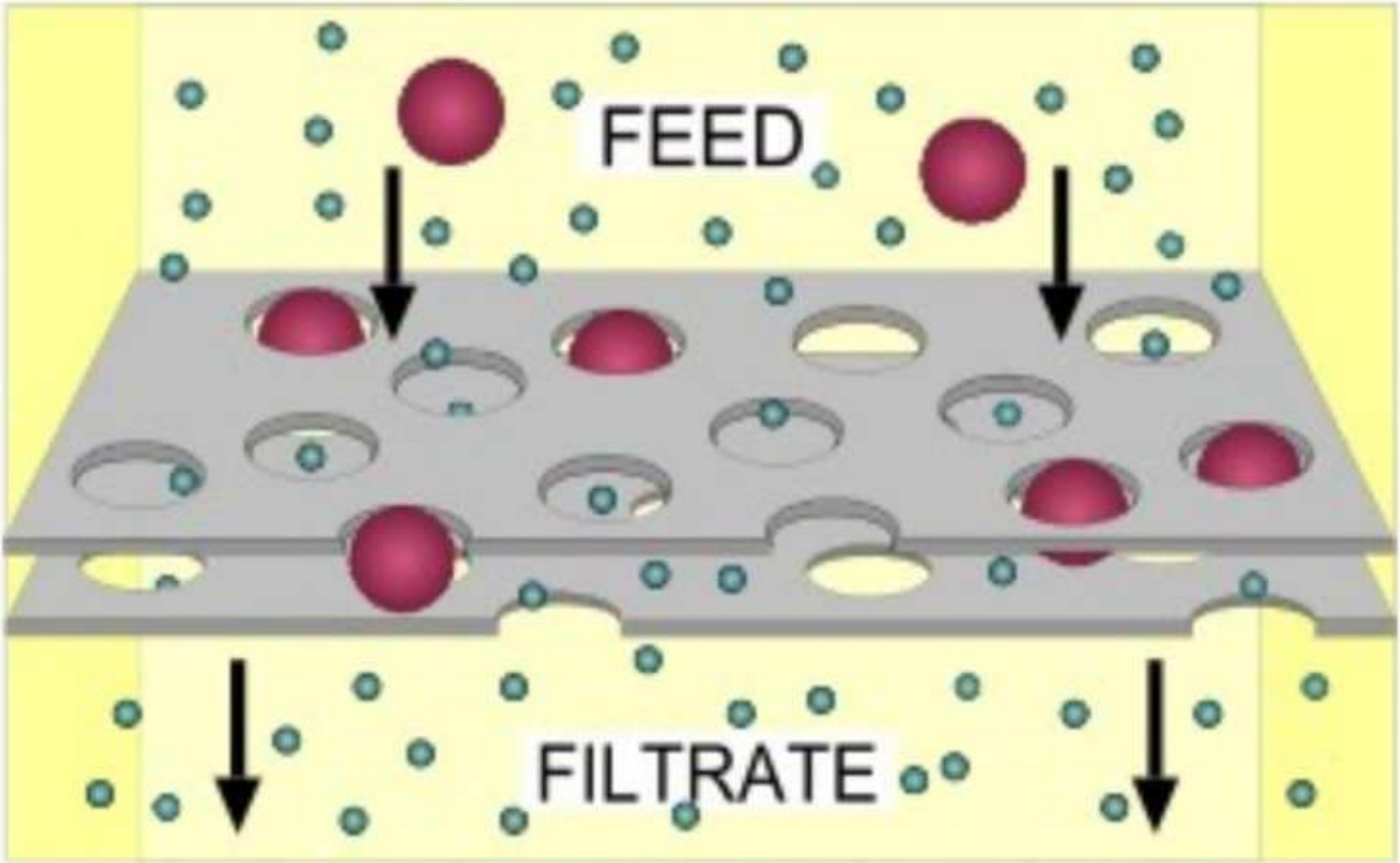
1. It should be chemically inert.
2. It should have low specific gravity.
3. It should be insoluble in the liquid to be filtered.
4. It should form a porous cake.
5. It should be readily recoverable from the liquid.

- Some filter aid used in the filtration are:

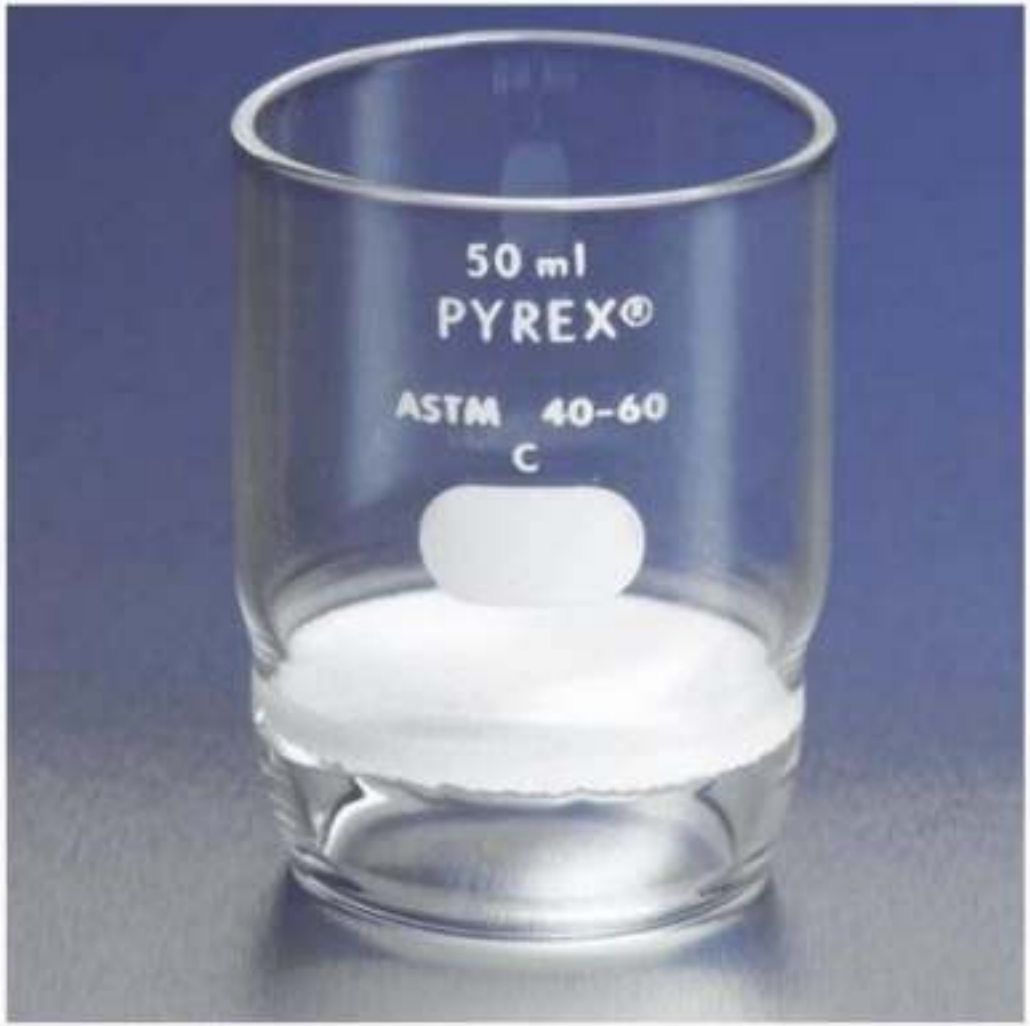
1. Hyflo
2. Talc
3. Charcoal
4. Magnesium Carbonate
5. Bentonite

Equipments for Filtration

1. Sintered glass filters
2. Filter candles
3. Filter press
4. Rotatory filter
5. Filter leaf
6. Filter funnel
7. Edge filter
8. Vacuum filter
9. Buchner funnel
10. Membrane filters


FEED
FILTRATE

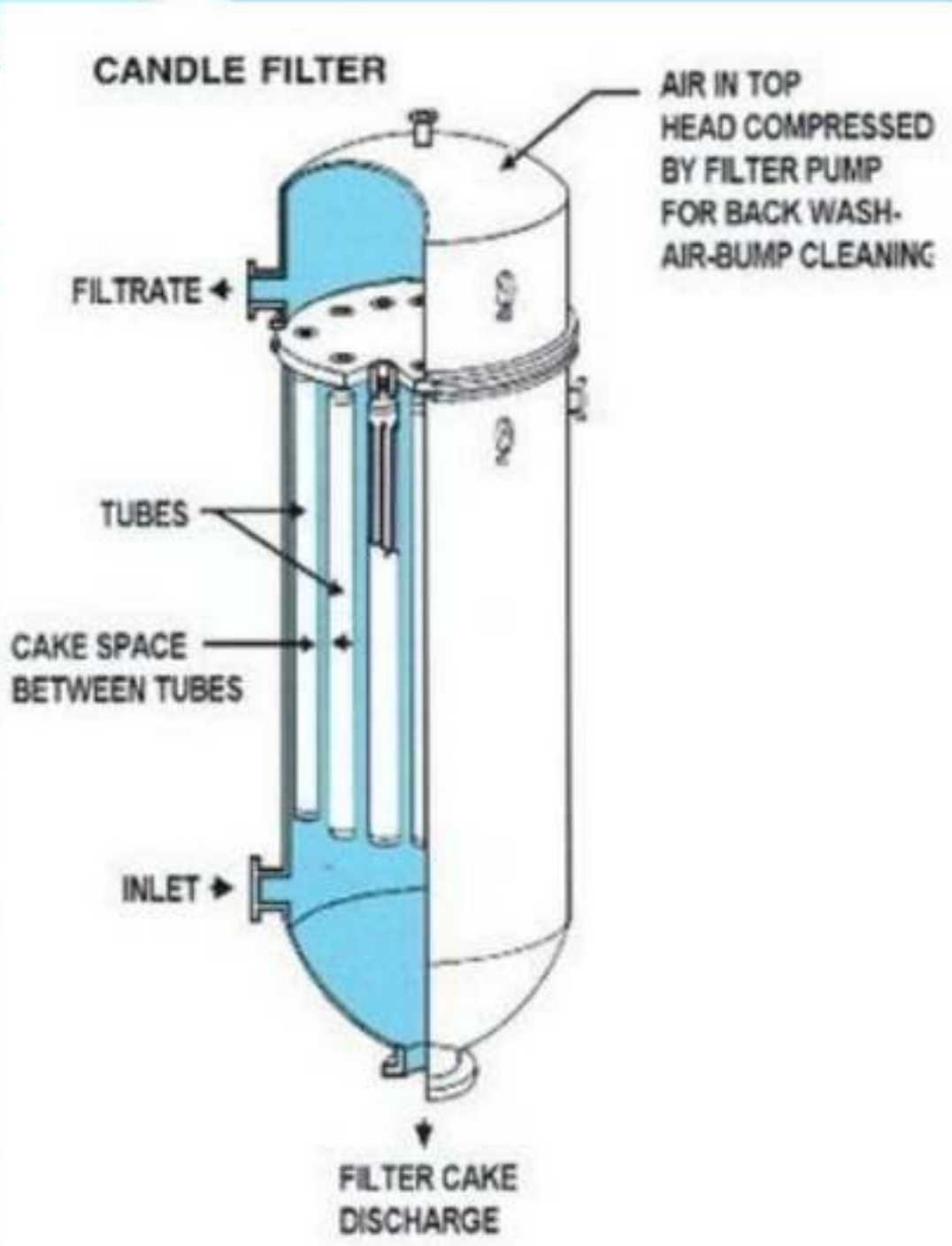
Sintered glass filter



- Sintered glass filters consists of sintered glass particles with very small porosities fitted in pyrex funnel.

  (Sinter- To fuse together by heating without melting)
- The porosity of sintered glass filter depends upon the size of glass particles used.
- They are used for the filtration of parenteral products, opthalmic preparations, etc.
- For bacterial filtration grade 5 sintered glass is used which can filter upto 2µm.
- Sintered glass filters are very fragile, so they must be handled carefully.

Filter candles



- Filter candles are cylindrical tube made up of porcelain or kieselguhr containing filter elements with different porosity grades. It is connected to vacuum pump for reducing pressure during filtration.
- Filter candles consists of 3 major components:

❑ The vessel

❑ The filtering elements

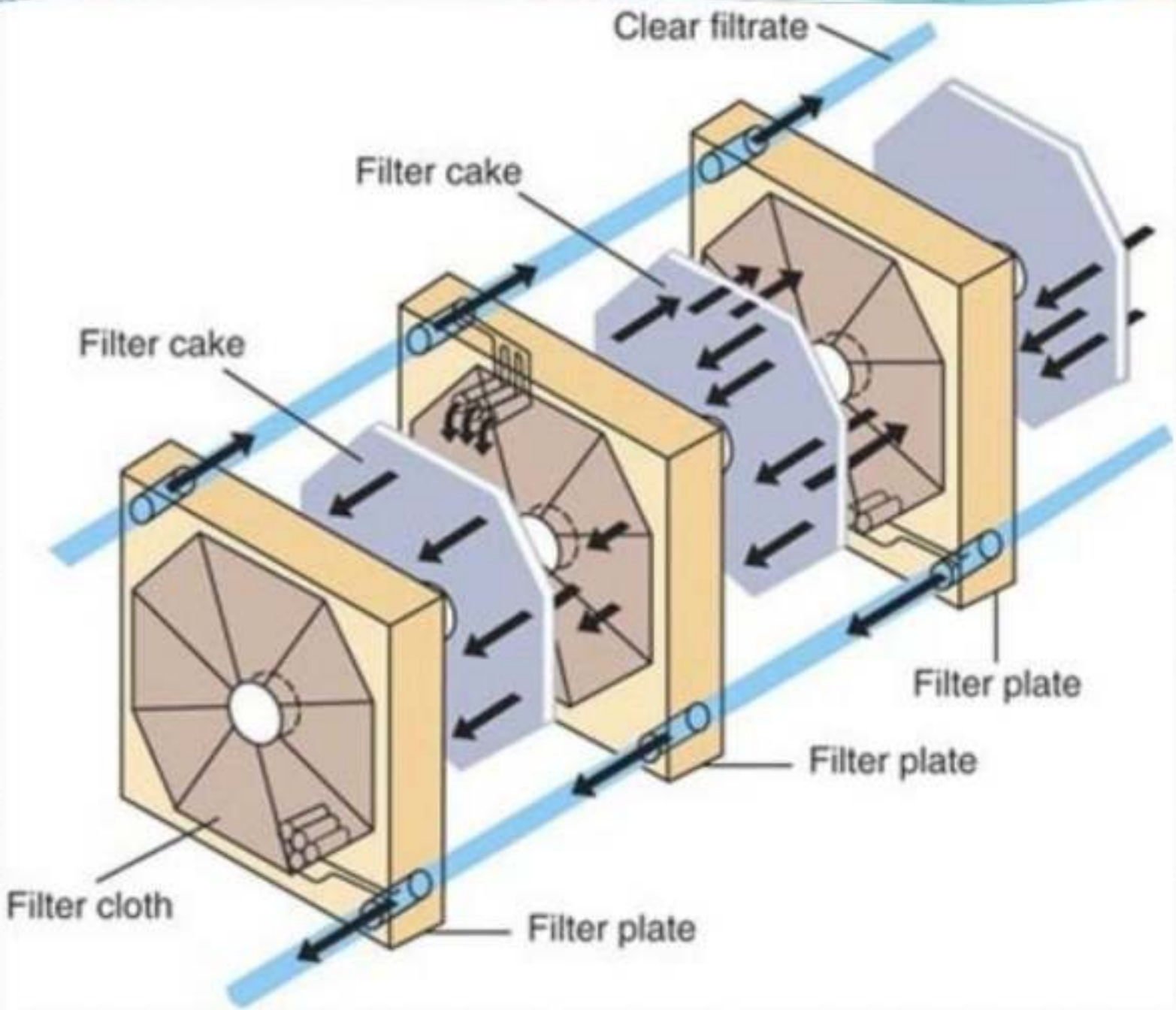
❑ The cake discharge medium

- The liquid to be filtered is passed through the bottom inlet which allows fast settling of solid & cake formation.
- It is used for the sterilization of the solutions.

Filter press

- Filter press consists of number of frames & plates arranged alternatively used for industrial filtration. Each set of frame & plate works as a unit. Frames are open with inlet for liquid to be filtered. Plates have grooved surface to support filter cloth & contains outlet for filtrate.

- The liquid to be filtered is passed through filter press under pressure. The liquid passes through filter medium on the plate & filter cake is retained in the frame. Finally, filtrate is collected through the outlet.


Clear filtrate
Filter cake
Filter cake
Filter plate
Filter plate
Filter cloth
Filter plate

Advantages of filter press:

1. It is simple in construction.
2. It provides large area for filtration.
3. It is easy for cleaning & maintainance.
4. Filter cloth can be easily replaced.
5. Filter media can be selected according to porosity grade.

Disadvantages of filter press:

1. It is used for batch filtration, so small scale filtration is not economical.
2. Operation cost is high.
3. It is suitable for slurries containing less than 5 % solids.